

COGENERATION CASE STUDIES OF THE DoD FUEL CELL DEMONSTRATION PROGRAM

Mr. Franklin H. Holcomb

Dr. Michael J. Binder

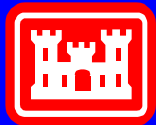
Mr. William R. Taylor

USACERL

[*www.dodfuelcell.com*](http://www.dodfuelcell.com)

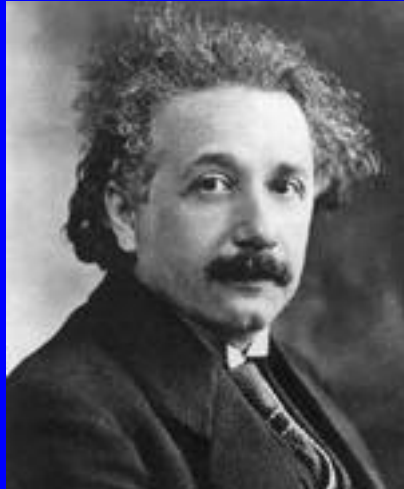
February 29, 2000

IQPC F-CELLS Stationary Conference, London U.K.



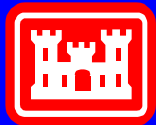
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**"Mathematics are well and good
but nature keeps dragging us
around by the nose."**

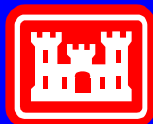
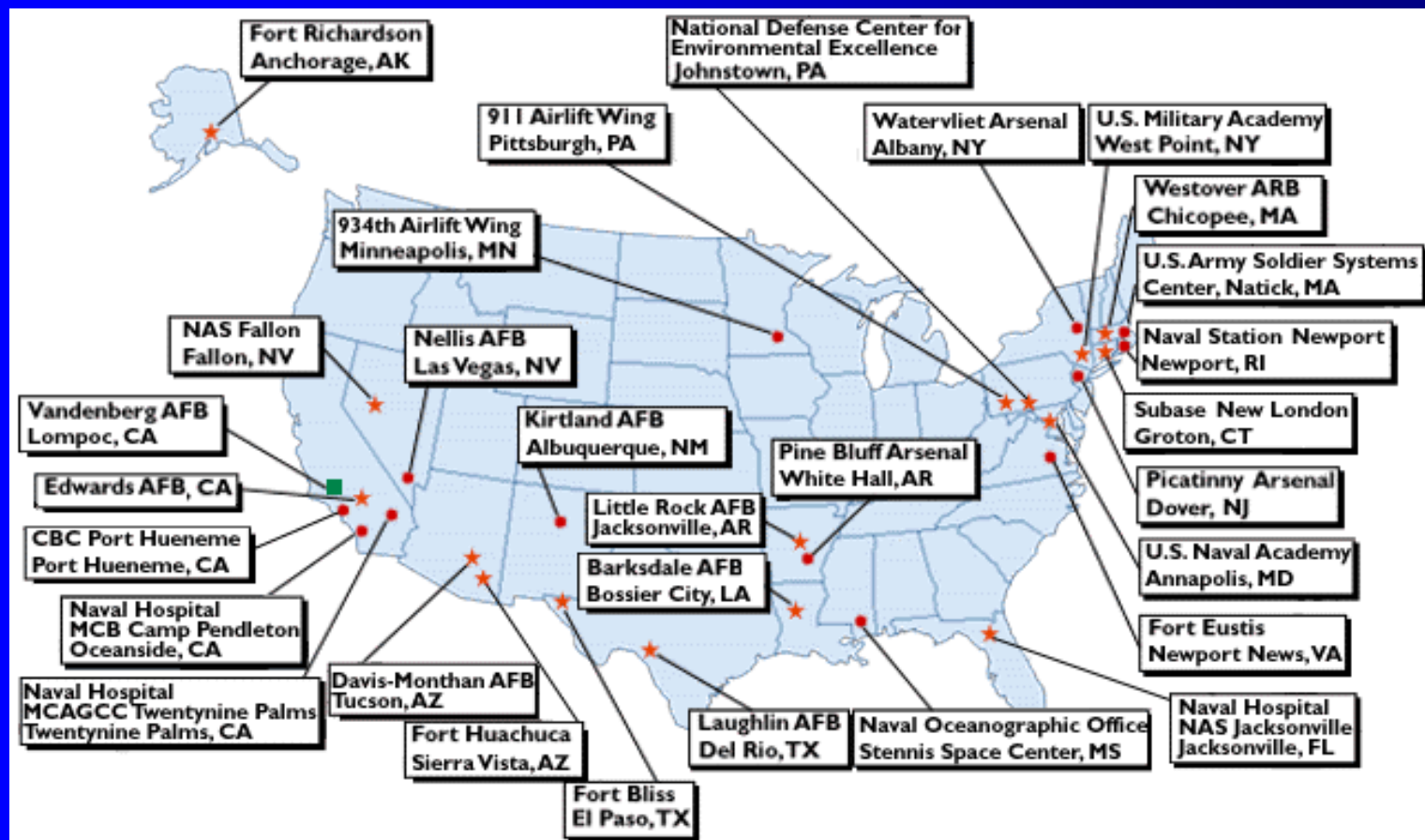
**Quoted in A P French,
Einstein: a Centenary Volume**



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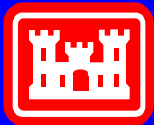
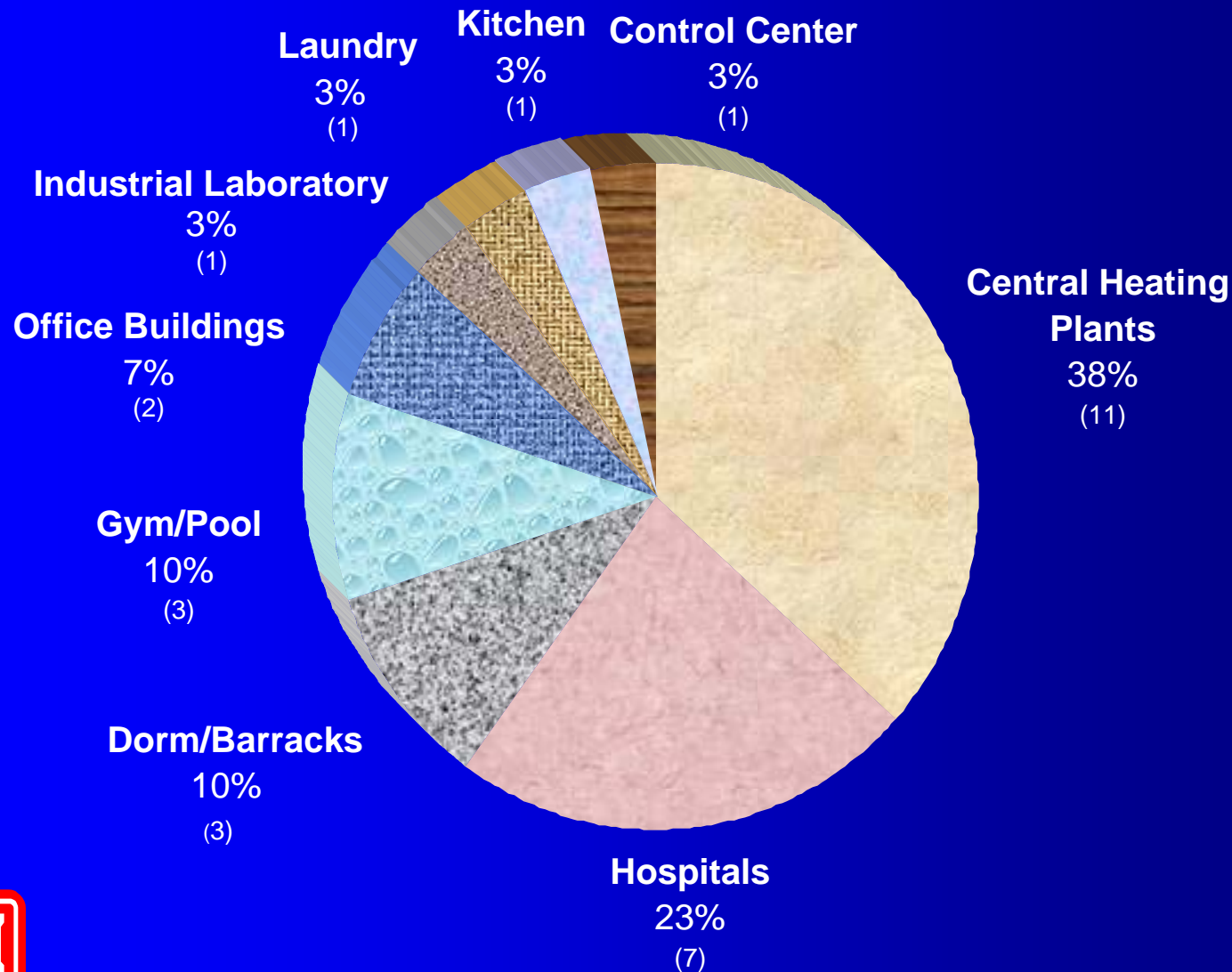
Program Sites



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Building Applications



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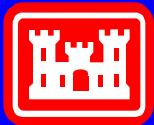
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Fleet Performance Summary

(29 Power Plants)

As of 1 Jan 2000

- Total Run Time 523,422 hrs
- Unadjusted Availability
 - Model B Fleet 60%
 - Model C Fleet 79%
- Energy \$ Saved \$3,654,917
- NOx Abated 172 tons
- SOx Abated 368 tons
- CO Abated 15 tons
- CO₂ Abated 21,850 tons

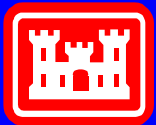


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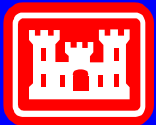
Thermal Interface Issues

- Potable Water Requirements
- Retrofit System Design
- High/Low- Grade Heat Exchangers
- Temperature Compatibility
- Pipe Material Compatibility
- Low/Intermittent Thermal
- Water Separation
- Changing Site Characteristics



Case Studies

- Central Heating Plant
- Space Heating Loop
- Swimming Pool



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Case Study 1: Central Heating Plant

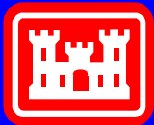


Picatinny Arsenal
Dover, NJ

PC25B - October 1995

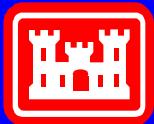
Electrical: Grid-connected at existing panel.

Thermal: Pre-heat boiler make-up water.
No condensate return.



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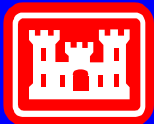
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Case Study 1:

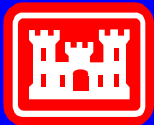
Site Evaluation Data

Length of Piping/Wiring Runs:

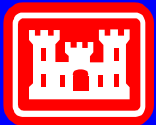
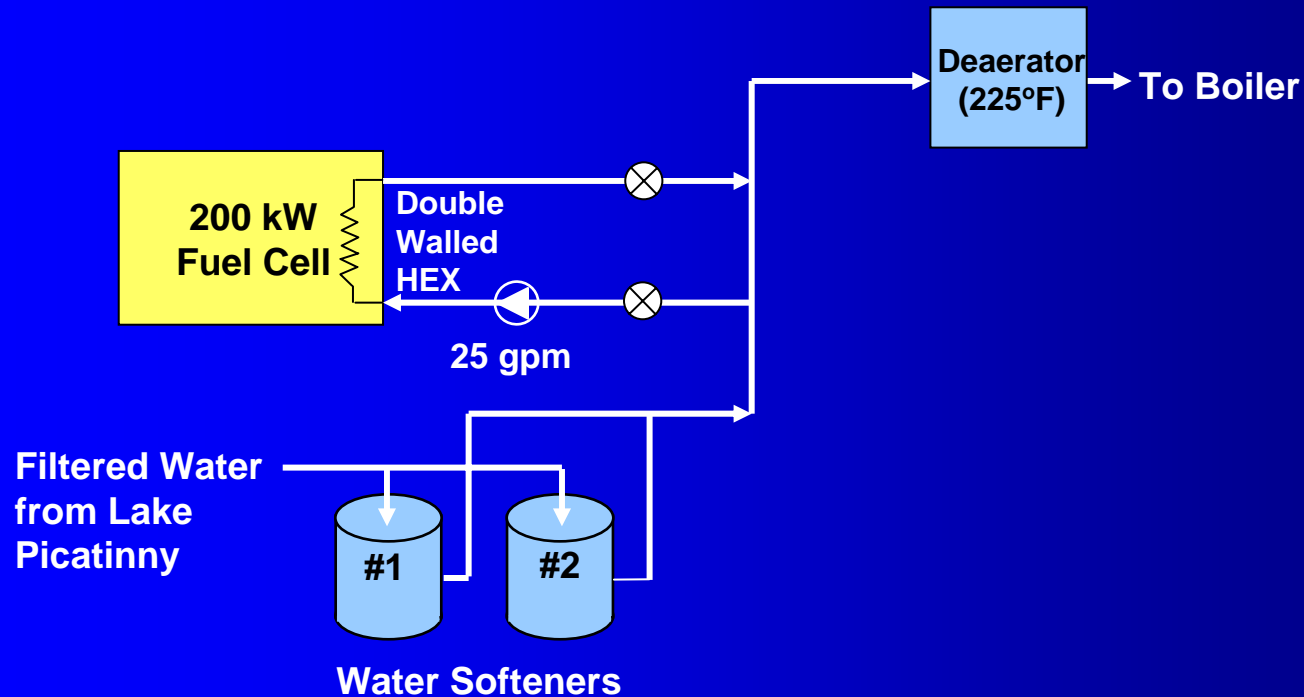
Electrical (to transformer)	~250 feet
Thermal (to mech. Room)	~200 feet
Natural Gas	~25 feet
Cooling Module	~20 feet

Estimated Energy Bill Savings:

Electrical Savings	\$121,000
Thermal Savings	\$ 25,000
Natural Gas Cost	(\$ 52,000)
NET SAVINGS:	\$ 94,000



Case Study 1: Thermal Interface

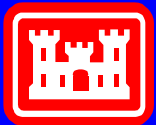


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Case Study 1: Results Summary

- Make-up water from nearby Lake Picatinny.
- Recovery exceeds 1 MMBtu/hour on occasion.
- Highest thermal recovery in Program.



Case Study 2: Space Heating Loop

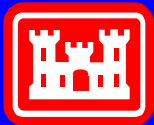


Edwards Air Force Base
Edwards AFB, CA

PC25C - July 1997

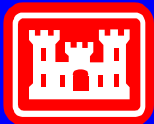
Electrical: Grid-connected at site transformer.

Thermal: Pre-heat space heating return loop
prior to steam heat exchanger.



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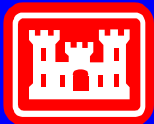
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Case Study 2:

Site Evaluation Data

Length of Piping/Wiring Runs:

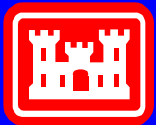
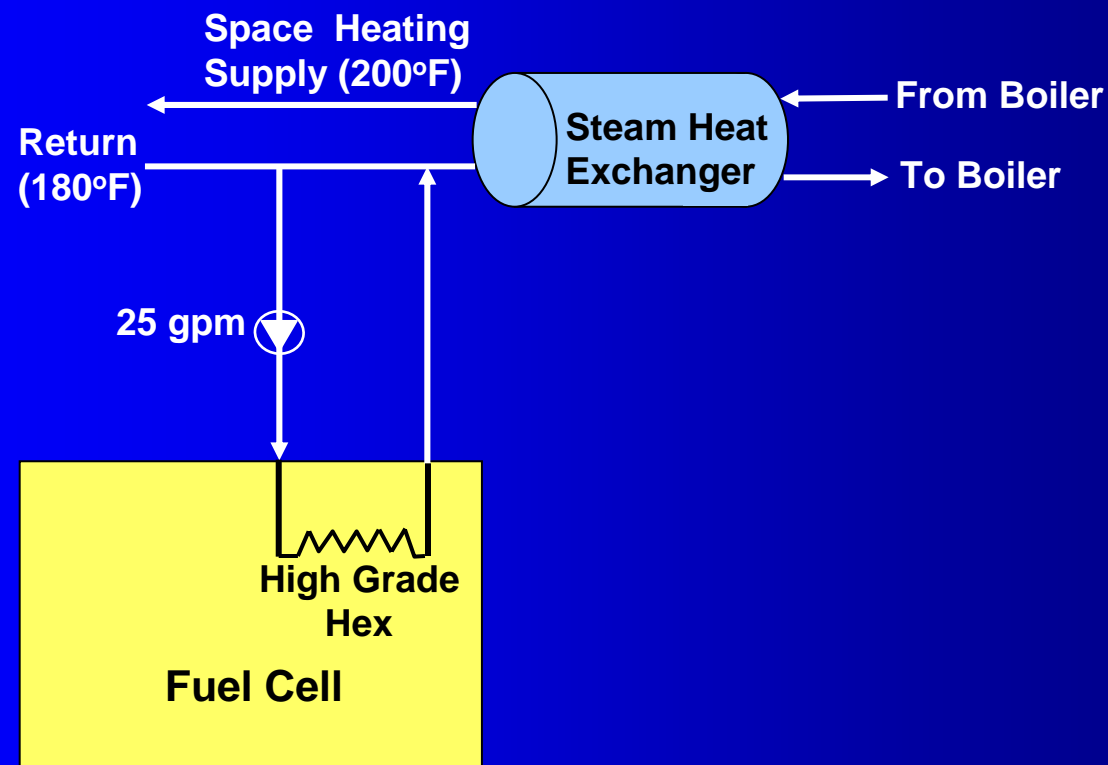
Electrical (to transformer)	~60 feet
Thermal (to space heat loop)	~20 feet
Natural Gas	~40 feet
Cooling Module	~20 feet

Estimated Energy Bill Savings:

Electrical Savings	\$122,000
Thermal Savings	\$ 3,000
Natural Gas Cost	(\$ 29,000)
NET SAVINGS:	\$96,000

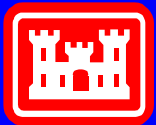


Case Study 2: Thermal Interface



Case Study 2: Results Summary

- Year round space heating requirement (unusual).
- High-grade heat exchanger required.
- Average load estimated to be 1/2 the output capacity of high-grade heat exchanger.



Case Study 3: Swimming Pool



Fort Eustis
Newport News, VA

PC25B - September 1995

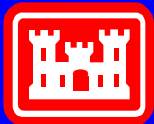
Electrical: Grid-connected at site transformer.
Grid-independent connection.

Thermal: Swimming pool make-up water and
pool recirculation loop.



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Case Study 3:

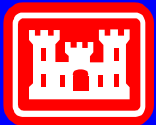
Site Evaluation Data

Length of Piping/Wiring Runs:

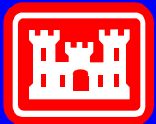
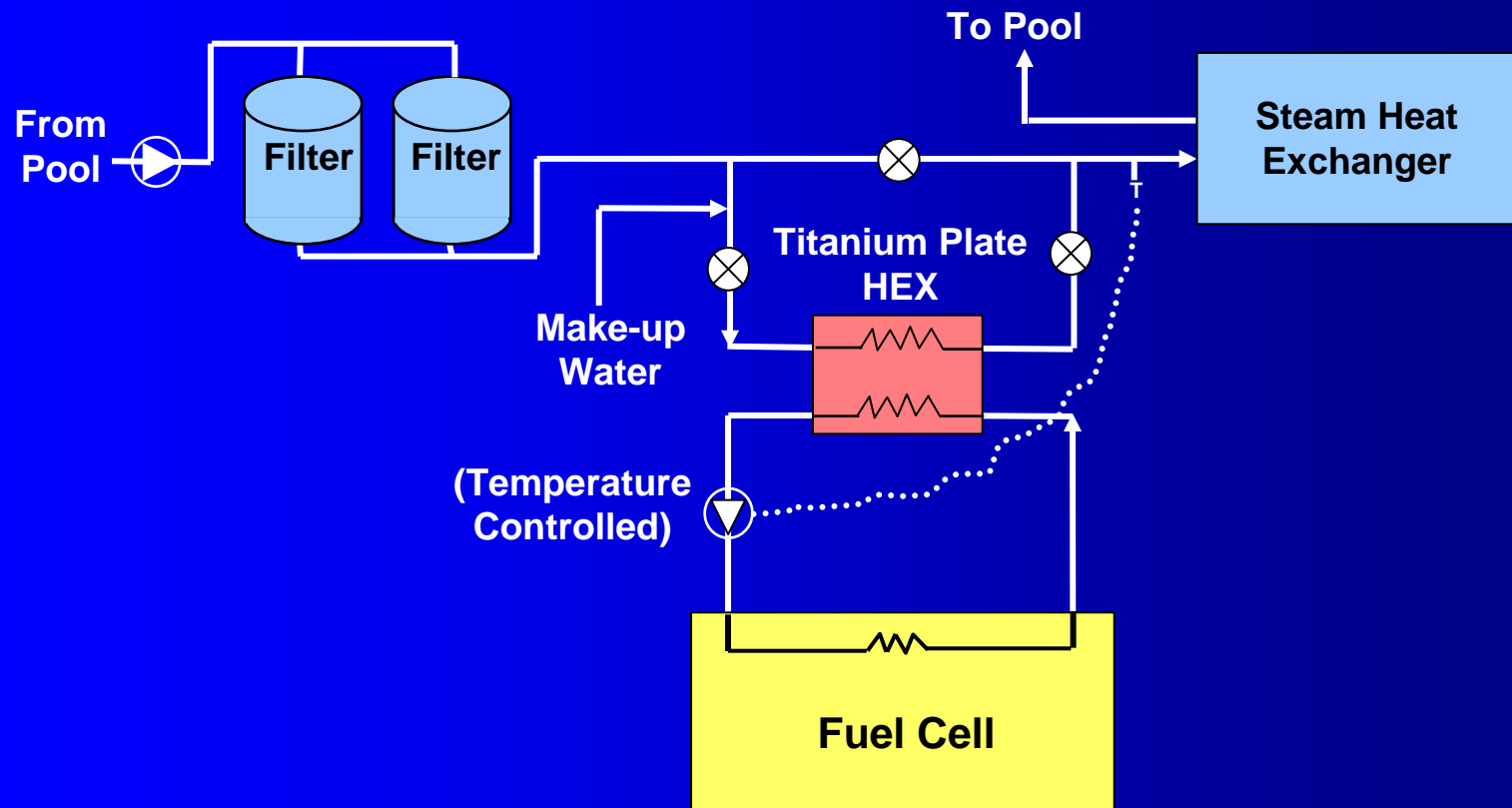
Electrical (to transformer)	~80 feet
Thermal (to mech. Room)	~20 feet
Natural Gas	~250 feet
Cooling Module	~20 feet

Estimated Energy Bill Savings:

Electrical Savings	\$ 62,000
Thermal Savings	\$ 20,000
Natural Gas Cost	(\$ 41,000)
NET SAVINGS:	\$41,000



Case Study 3: Thermal Interface

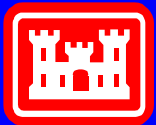


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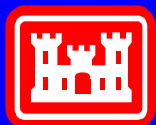
Case Study 3: Results Summary

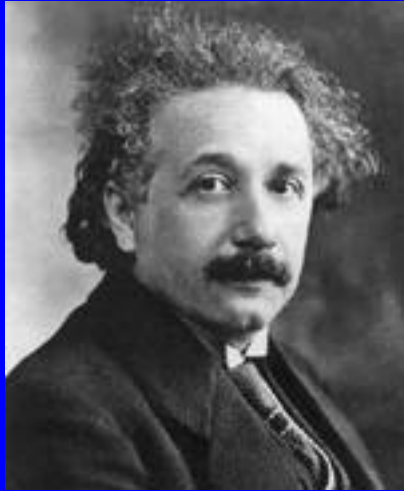
- Intermediate heat exchanger required to separate water streams.
- Pool water leak repairs reduced the 60% thermal utilization estimate to 18%.
- Gas rate structure limited fuel cell operation to 7-8 months per year.



Summary

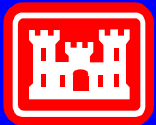
- Successful demonstration of fuel cell cogeneration in a wide variety of building and climate applications.
- Thermal interface was most significant site issue in DoD Program.
- Many conceptual and technical lessons learned that can be applied to future projects.
- *Please visit - <http://www.dodfuelcell.com> for more information.*





"Everything should be made as simple as possible, but not simpler."

**Albert Einstein
Reader's Digest. Oct. 1977**



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